Optimisation of thermoforming processes by means of combined in-situ measurements and simulations

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PRESENTATION SUMMARY:

Commercial thermoforming as known today began about 75 years ago. Unlike other major thermoplastic production processes such as injection moulding and extrusion that went through significant technological improvements, thermoforming on an industrial scale still remains a processing technique that is mainly based on operator experience and trial and error. The reason for this is mainly the lack of knowledge on the influence of process parameters and surrounding conditions on the material behaviour.

Insight in thin gauge thermoforming, a thermoforming variant for the processing of thin sheets and foils that is mainly applied in the packaging industry, has recently been improved by the introduction of in-mould monitoring systems. These systems allow for an in-situ measurement of among others: pressures, temperatures, positions and forming forces. In heavy gauge thermoforming however, such tools are not yet available. Typically, the quality of heavy gauge products is assessed on the basis of (manual) tactile, point by point thickness measurements in cross sections or parts of the final product. This makes it hard to define the relation between a specific process setting and the resulting thickness distribution, influenced by all (non-ideal) boundary conditions.

In this presentation, an experimental methodology to increase process insight in heavy gauge thermoforming will be shown. The methodology is based on in-situ, full-field measurements of deformations, combined with pressure and temperature measurements. It will be demonstrated that the use of the methodology provides valuable insights in every step of the thermoforming process and that the proposed approach allows to define the process settings that are responsible for the quality of the final product. Besides this direct benefit, the approach can also be used to (i) identify specific thermoforming simulation parameters, (ii) establish the link between simulation and process parameters and (iii) facilitate the comparison of simulation results with results from production.

From an industrial point of view and with the increasing urge for automation it is clear that this enhanced insight into the process and the possibility to more accurately execute simulations can make heavy gauge thermoforming more stable, reduce start-up and cycle times and minimise the need for operator experience.